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The Improvement of Instruction in Arithmetic

By
F. P. OBRIEN

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The Improvement of Instruction in Arithmetic

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I. NATURE AND SCOPE OF THE PROBLEM

The study reported here deals with the technique and results of a school experiment pertaining to the improvement of instruction in arithmetic in the two upper elementary grades and also with the bearing of this subject upon achievement in high school mathematics. *First,* by means of a diagnosis of student achievement in various phases of arithmetic the strong and weak features of the work were disclosed. *Secondly,* a definite plan of procedure was outlined and followed for the purpose of securing improvement of the instruction results. As a *third* step in the study, the outcome or results of the experiment were analyzed so far as they were made evident in the achievement of the students taught. The results reported pertain chiefly to the year 1925-26. The general plan of this study resembles rather closely a similar study pertaining to English which was made by the same author and reported as "An Experiment in the Supervision of English."[1]

Three small school systems, all located within twenty-five miles of the University of Kansas, so that they were easily accessible for such an experiment, participated in the study. The writer and an assistant[2] attempted to perform some supervisory functions mainly with reference to instruction in arithmetic. The grades from seventh to tenth inclusive were involved. The study represented a cooperative undertaking on the part of these three schools and the Bureau of School Service and Research of the University of Kansas. Cooperative studies of this type are regarded as of mutual and practical advantage to both the University and the participating schools.

The seventh and eighth grades seemed to be appropriately included for such a study because they represent the most

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[1] Vol. 1, No. 6 Kanas Studies in Education. Bulletin of Univ. of Kansas.

[2] Victor H. Kelley, who was research assistant in the Bureau of School Service and Research, assisted the writer in conducting this study.

advanced grades which provide direct instruction in arithmetic, while the first two years of high school were included in the experiment because the work of students in advanced phases of mathematics is likely to be conditioned rather markedly by their proficiency in the handling of the fundamental processes. A diagnosis of instruction in order to disclose the specific weaknesses of students in high school mathematics would surely need to include a consideration of their proficiency in the preparatory work.

While much has been written and spoken concerning the improvement of instruction and the supervision of teaching, the treatment given to these activities is frequently more general than specific. The literature which pertains to these activities does not often give in sufficient detail the exact steps employed. *There are advantages in knowing precisely what one does in practice when one supervises in a given situation.* This need of specific information does not seem in conflict with the employment and adaptation of many and varied procedures. Description of both the situation and the procedure is needed.

Guided by the feeling that there is a practical need for more definite, precise, and detailed treatment of procedure to supplement the more general and suggestive discussions of supervision, *this report presents in considerable detail the method, emphasis, and technique which were employed.* Without such information one cannot know whether the plan and method employed in two situations are essentially the same or distinctly different.

II. Diagnosis of the Situation

If one were to attempt a really complete diagnosis of the situation pertaining to even a single subject of instruction, it would, of course, require a rather extensive, varied, and at the same time intensive sort of analysis of the elements involved. The elements which may enter into or condition the performance of students in a subject may be mental, physical, social, emotional or instructional, and they may be traceable to such contributing causes as home influences, habits of study, methods of teaching, previous training, content of instruction, specific difficulties in the subject or effectiveness of

the student's application. *This study does not represent a complete diagnosis, as it has been confined chiefly to the factors of mental ability, the student's performance in specific phases of the subject, and the effect of previous training,* so far as different types of schools may be responsible for the training.

Since all students in the elementary school are concerned with the study of arithmetic and practically all freshmen in high school are concerned with the study of algebra, practically no chance existed for selection, with reference to the students pursuing these subjects excepting as withdrawal of students from school may have involved a selecting of those who disliked school mathematics. In view of the fact that arithmetic is prescribed in all of the schools in the state, with no option left to the student, no attempt was made in this study to discover the effect of the interest or attitude of students with reference to the subject. Neither was any attempt made to gauge the influence of home conditions or habits of study on the achievement of the students. It seemed necessary also to accept, tentatively at least, the content of instruction as it is prescribed in the state course of study.

A series of tests were given by the writer or his assistant late in November in each of the three schools to the four classes as previously indicated. *The period of this experiment pertaining to the improvement of instruction extended over approximately five months following the completion of this testing program. The tests employed comprised:*

The Courtis Test in the Fundamentals of Arithmetic
The Woody-McCall Test in Mixed Fundamentals
The Buckingham Test in Arithmetic Problems
The Thorndike-McCall Reading Test
The Van Wagenen Reading Test
The Hotz Algebra Scales
The Rogers Test of Mathematical Ability
The Terman Group Test of Mental Ability

Not all of these tests were given to all classes. The Rogers test was administered only to the sophomore classes, the Hotz algebra test, likewise the Van Wagenen reading scale only to freshman classes. After these tests had been given they were scored by the teachers or by other competently

trained persons. All test scores were later carefully checked for the purpose of detecting any errors in the scoring. Tabulations of the scores were made in the several tests for each class and each school separately. These tabulations provided the basis for the greater part of the diagnosis.

The distribution by schools and classes of the number of students involved in this study is shown in Table I. As none of the three schools had a very definite junior high school organization, the ninth and tenth years are regarded as the first two years of a four year high school and the seventh and eighth grades as the most advanced grades of the elementary school. In Bonner Springs, however, the seventh and eighth grades had departmentalized instruction and the term 'junior high school' was employed to some extent.

TABLE I. *Schools and Classes Involved in This Study*

Grades	VII	VIII	IX	X	Totals
Schools					
Bonner Springs	29	30	58	42	159
Perry	15	24	35	19	93
Tonganoxie	19	16	37	33	105
Totals	63	70	130	94	357

This table indicates that a total of 357 students were involved in this experiment. By classes, the numbers varied from 63 to 130 students. The enrollment of the freshman class (IX) very much exceeded the enrollment in the other grades due to the fact that many freshmen are enrolled from rural school districts and that many students do not continue in high school beyond the freshman year.

In the tabulations the achievement scores in this study have been combined to form single composite tables for the three schools as though they had jointly comprised only a single school.

The Mental Ability Factor.—The chief purposes in the use of a group mental test in this study were (1) to provide evidence of whether the students involved in this experiment were of a selected type with reference to mental ability and (2) to make possible a fuller analysis and interpretation of the achievement scores of individual students. It seemed important to know whether the scores in a mental ability test in-

dicated that the students in any of the classes or schools were not typical but were a selected group with reference to their ability to succeed in school work. *The analysis of the mental test scores indicated that the students in these schools represented a distribution of mental ability which did not differ greatly from what is found in other high schools of similar size in the state.*

TABLE II. *Median Scores in Terman Mental Ability Test (in November)*

Grades	VII	VIII	IX	X	Total Students Tested
In This Study	66	82	93	105	322
Other Kansas Schools	67	87	97	113	8,466
Terman Standards	68	89	104	122	32,000

Complete tabulations of the test results will not be presented here. The essential facts of the tabulations may be indicated for the reader by reporting the median (average) scores (and marked variations from these) to make possible the comparison of the average scores by classes and also comparison with standard scores so far as these are available. The diagnosis which was made actually involved a careful analysis of individual scores also, and comparison of these with standard scores, class norms, and mental ability scores. The average scores made in the November tests will be compared later in the report with the average scores made in similar tests in May to indicate the amount and rate of progress which the students made.

Rate and Accuracy in Computation—The median scores are presented in Table III for each of the classes in the four divisions of the Courtis arithmetic test. This test was used because of its simplicity and definiteness for teachers and students rather than because of other virtues which it may possess or lack. It has been criticized as being too formal and lacking the variety of exercises needed for measuring achievement in these processes. But the test exercises are uniform in difficulty, easily legible, and the directions are easily understood by pupils. It apparently possesses both advantages and limitations as a test.

Since not all of the students took the Courtis test, the number in Table III does not correspond with the number students reported in Table I. The standard scores as published by Courtis are presented for grades VII and VIII.

TABLE III. *Median Scores in Courtis Arithmetic Test Fundamental Processes (Series B Test)*

Grades	VII	VIII	IX	X	Total
Addition	4	5.5	5.2	5.5	
Standard Score	11	12			
Subtraction	6	7	8	8.8	
Standard Score	12	13			
Multiplication	5	5.8	5.1	5.4	
Standard Score	10	11			
Division	3	4	4.9	6.3	
Standard Score	10	11			
No. of students	53	56	84	50	243

For most purposes the standard scores which apply to grade eight may also be applied to classes in advance of grade eight. One may readily observe by reference to this table that *the average scores made in the addition test fell far short of the normal or standard scores. In fact, the same observation may be made with reference to the average scores in each of the four fundamental processes as measured by the Courtis test.* In both addition and multiplication the best class averages were approximately one-half of the standard eighth grade score. So far as one may accept the results in this test as a definite indication of their work in the mechanical processes of arithmetic, he must conclude that *these students are strikingly slow or ineffective, or both.* It would seem reasonable to expect that other phases of the subject would almost certainly be conditioned by such inadequate performance in the simple mechanics of the subject.

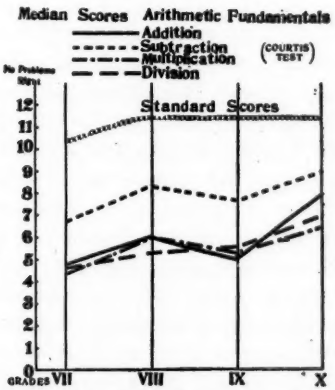
A full tabulation of the scores in this test discloses several facts or features which are not made evident in the statement of average achievement in Table III. For example, the range of scores in the addition test was from 0 to 16. Five students made a score of zero in the addition test, four made a like score in multiplication, and thirteen scored zero in the division test. The time allowed for the four divisions of this

test was eight, four, six and eight minutes respectively. *The test was simple and the directions adequate, yet twenty-three of these test scores were zero,* which indicates that no problem was correctly worked by the individuals who made that score.

It is evident from facts in the preceding table that in not any of the four grades was the average score in addition equal to six problems, which is the published norm or standard for fourth grade students. *It also appears from the complete tabulation of scores that in the addition test approximately fifty percent of the freshman classes in high school did not equal the standard score for fourth grade pupils.* Practically the same statement could be made with reference to the division test. The percentages of freshmen which fell below the standard score of the fourth grade in the subtraction and multiplication tests, were 40 and 67 respectively. Such a situation must be taken into account in any effective effort to improve instruction results in mathematics.

Facts similar to those shown in Table III are presented in graphic form in Chart I. The graphic statement pertains to only one of the three schools and it represents one of the charts which were prepared for showing students the need

CHART I



of improved achievement in their work. *One may easily observe that the average score of the ninth grade was lower*

than the eighth grade average in three of the four processes tested. The relation of these scores to standard scores in the test is also shown in the chart.

Whether the low scores disclosed in the preceding table were traceable to slowness in computation, to prevalent inaccuracy, or to both, demanded further inquiry. The median accuracy scores of the students in the same computation test are shown in Table IV. The scores represent the percentages found by dividing the number of problems right by the number of problems attempted. The scores in accuracy were first computed for each individual in the four divisions of the test. The median scores in accuracy were then computed after tabulating such individual scores.

TABLE IV. *Median Accuracy Scores in Courtis Arithmetic Test (Expressed in Percentages)*

Grades	VII	VIII	IX	X
Addition	44	54	55	62
Subtraction	69	73	71	76
Multiplication	47	60	50	57
Division	56	63	72	71

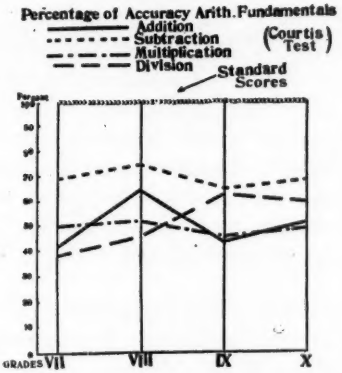
In this table sixteen median scores are presented showing the average degree of accuracy of the four classes in each of the four tests in arithmetic fundamentals. Three of these scores do not exceed fifty percent. Five others do not exceed sixty percent. Thus half of the accuracy scores in this table (3+5) do not exceed sixty percent in accuracy. In other words, these high school and advanced elementary classes were apparently able to get the correct results in only a little more than half of the simple computations which they worked in these formal tests. *They apparently lacked accuracy in their computations to a degree which must be regarded as a serious deficiency.* One hundred percent is now regarded as the only admissible standard of accuracy in arithmetic.

These facts would seem to be of considerable practical value for the teacher of arithmetic, algebra, or geometry. That these students are in general both slow and inaccurate in handling the mechanical processes will of necessity condition their achievement in other subjects which involve these skills. In fact, a practical diagnosis of mathematics teaching

demands such information. *One may well assert that the teaching of any mathematics in high school cannot be satisfactory until such elementary deficiencies are corrected.*

The lack of accuracy which in general characterized the simple computations of these students is shown, by classes, in Chart II. An interesting feature made evident in the chart is that the highest accuracy score made by each of the four grades was in subtraction. The standard scores in accuracy seem to constitute a distant goal for the groups of students represented in this graph.

CHART II



Another fact which should be of vital concern to teachers of mathematics is disclosed by a further analysis of these test scores. The viewpoint has been traditionally accepted that students who are slow are usually more accurate or more reliable in their work and, conversely, students whose normal rate of work is more rapid are more prone to inaccuracy and careless performance. There is now abundant and convincing evidence available to show that such a viewpoint is far from being uniformly true. The truth is, that the slow pupil is usually (but not always) more inaccurate and the student who is normally more rapid is also usually more accurate. The table which follows indicates that in the Courtis test the students who attempted more computation exercises attained a higher score in accuracy than did those who attempted a

smaller number. This table presents the facts for the four classes combined, showing the analysis of accuracy scores in addition and multiplication tests.

TABLE V. *The Positive Relation of Rate and Accuracy in Arithmetic Computations (Courtis Test)*

	No. of Problems Attempted:					
	3 or 4	5-6	7-8	9-10	11-12	13-14
Accuracy Scores:						
In Addition	33	50	58	66	67	70
In Multiplication	50	59	63	60	65	66

One may note that students who tried fewer than five problems in addition got 33 percent (1 in 3) of them correct and those who tried nine or ten got 66 percent correct (2 in 3). *It is easily apparent from this table that the students who attempted a larger number of problems had a higher accuracy score than did those who attempted only a smaller number.* Moreover, the increase in the accuracy score was continuous and consistent for each higher step in the scale in both of the tests reported here with a single exception in the multiplication test. The results were similar in the subtraction test, but they were not so marked and consistent in the division test.

Further effort was made to analyze the achievement of these students in the fundamental processes of arithmetic. For this purpose the Woody-McCall test in mixed fundamentals was employed. The test differs from the Courtis Test in that it employes a considerable variety in the types of problems or exercises which involve each of the fundamental processes. This test was given to the students in three grades not including the sophomore classes. The median scores by grades in this test are shown in Table VI. The standard scores are also presented for purposes of comparison.

TABLE VI. *Median Scores in Woody-McCall Mixed Fundamentals Test.*

Grades	VII	VIII	IX
Medians	24.3	27	28.4
Standards	26.5	28.2	

It appears that the average score of high school freshmen equals the standard for the eighth grade class and that the

average score of the eighth grade is slightly above the standard score for the seventh grade. *From these facts it would appear that these grades were approximately one year below the standard achievement score in fundamentals when measured by the Woody-McCall test.*

Problem-Solving Ability of the Students—The way in which training in arithmetic functions most often in later life concerns the solution of problems, involving thinking, reasoning and computation. For the purpose of measuring this reasoning ability or problem solving ability of the students, the Buckingham problems test in arithmetic was employed. In Table VII the distribution of achievement scores in this test are shown by classes and a comparison of median scores may be made with standard scores.

TABLE VII. *Distribution of Scores in Problem Solving Test (Buckingham)*

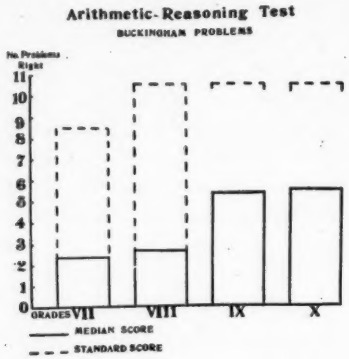
	Scores (No. Right)										Med.	Std.
Grades	0	1 or 2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	Totals	Scores	Scores
VII	6	15	13	11	4	4	1	1		55	2.4	8.5
VIII	1	12	10	16	13	6	3	1	1	63	2.7	10.5
IX	2	14	16	17	12	18	9	4	2	94	5.4	
X		5	5	14	17	9	8	1	1	60	5.5	

The tabulation of the scores made by students in this test discloses the fact that there were students in three of the four grades who made a 0 score, that is, they did not work a single problem correctly. This was true in spite of the fact that some of the problems in the test are regarded as very easy. The range of scores in this reasoning test varied from 0 to 15. It is apparent from the facts stated in Table VII that in none of the four classes did the median score equal the standard score for the seventh grade. Each of the high school classes tested made an average score of three problems less than the seventh grade standard or about 65% of that standard (8.5 problems.)

It appears that in problem-solving ability, the seventh and eighth grades were three or more years below what is the expected performance of the standard score for those grades. The freshman and sophomore classes made average scores about one and one-half years below what is expected of the

seventh grade students. For one to appreciate the seriousness of this situation from the standpoint of the teacher of mathematics in the high school, does not seem difficult.

CHART III



In attempting to explain what factors account for the unsatisfactory scores made by these classes in the arithmetic reasoning test, one may need to consider among other possible explanations whether limited ability of the students to read problems understandingly or to comprehend what the problems involve is a contributing factor. It frequently happens that inability to solve a problem in arithmetic is traceable to inability to read the problem correctly rather than to inability to perform the computations involved. The scores made by these students in the Thorndike-McCall reading test indicate that a portion of their difficulty consisted in deficient ability to read.

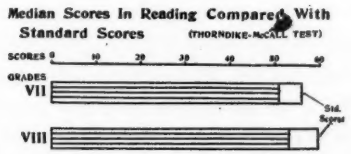
TABLE VIII. *Median Scores in Reading Tests*

	Thorndike-McCall		Van Wagenen
Grades	VII	VIII	IX
Median Score	51	53	13.8
Std. Scores (Jan.)	56	59.6	

The median score in reading made by the seventh grade was 51. That score is five points below the score which is normally expected of seventh grade students. Five points difference in this test is equivalent to nearly a year and a half

in reading achievement. The eighth grade students had a median score of 53, which is 6.6 points below the average score that is normally expected of that grade. *This means that their reading ability as represented by such an average score, is nearly two years below the standard score of eighth grade students in general.* The ninth grade students took the Van Wagenen reading test, using the 'science scale' division of that test. No standards are available for comparison here since the scoring of that test by a simpler method (rights-wrongs) did not conform to the plan of scoring upon which the norms are based, but it is still possible to compare the earlier and later scores of these students in the same reading test.

CHART IV



Other Tests in Mathematics—It seemed desirable to test the two high school classes in other mathematics than arithmetic, especially since those classes were studying algebra and geometry. The work of the freshmen in algebra was tested only in phases of the work which they had studied. The addition-subtraction test of the Hotz algebra scale was employed. The scores of the students thus tested varied from 0 to 7 problems, with a median score of 5. The standard score for students who have studied the subject three months is 5. Accordingly it appears that *in this portion of their algebra the freshmen were doing satisfactory work since their average score in November was equal to the three months' standard in the test.*

Only the sophomore group was given the Rogers test of mathematical ability. This test consists of six divisions or sub-tests. These divisions are: geometry, algebra, superposition, language comprehension, mixed relations and interpolation. Although definite standards are not available for comparison of the results in each division of the test, the dis-

tribution of scores is presented in the table which follows. As this test was repeated in May, it was then possible to indicate the progress made during the five months by these students in the content which is measured by the test.

TABLE IX. *Distribution of Scores in Rogers Test of Mathematical Ability*

Score	Less Than 4	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23	24-25	26-27	28-29	30 or More	Medians	Score Value
Geometry	12	8	5	6	6	7	2	5	7	3			1			10	80
Algebra	2	5	11	9	5	11	7	6	4	1	1					11	66
Superposition	3	3	3	4	2	5	5	2	5	5	4	1	5	2	13	19	57
Language Scale	3	4	5	12	10	11	5	7	5							11	66
Mixed Relations	3			2	4	3	2	4	8	2	6	5	8	6	9	23	46

Scores	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110 or more		
Interpolation	3	5	5	14	10	9	6	4	1	2	3	53	53

Table IX shows that there was a rather marked variation in the scores made by the 62 sophomores who took this test. In the geometry division of the test for example, 12 scored below four and three scored twenty or twenty-one. Such variation applied to the several divisions of the test. Thirty-two sophomores who were not enrolled in mathematics classes during the sophomore year were not asked to take the Roger's test. The score values indicated in the column to the right of the table are determined by weighting the median scores in the different test divisions as suggested by the author of the test. (8 x 10; 6 x 11, etc.)

The Previous Training of Students—The diagnosis of achievement results in arithmetic included still other steps in the analysis and interpretation of the various tabulations. Two of these steps will be indicated briefly in this report. The first pertained to the success of students coming to the high school from rural elementary schools in comparison with those coming from graded elementary schools. The second pertained to an analysis of specific errors with reference to test elements or types of problems.

Information was secured from the schools participating in this experiment with reference to which of the students in the two high school classes involved had received their elementary training in rural schools. Separate tabulations of the

scores of these students in the several tests disclosed that one of the difficulties which must be faced by high school teachers of mathematics pertains to this group of students. *The students who had a majority of their elementary schooling in rural schools comprised more than half of the freshmen in these high schools and they showed a lower average of achievement in several of the tests than did the students from graded schools.*

Perhaps the freshman students coming from rural schools had not yet become fully adjusted to the work of the high school. Whether that is true is not known but in the Buckingham problem-solving test, which deals with content presumably familiar to all students of freshman rank, *their average score was nearly two problems less than the average of the students coming from graded schools. That difference represents one year of progress in the subject.* The average score which they made in the Van Wagenen reading test was 2.2 points (or 16 percent) below the average score of those coming from graded schools. In the Woody-McCall mixed fundamentals test there was also a distinct difference in the same direction. In the Courtis test in fundamentals the advantage of students coming from graded schools did not seem to be so marked or so consistent as in the tests already mentioned.

Analysis of Errors—The analysis which was employed with reference to specific errors or difficulties of students may be illustrated by using the Buckingham problems test for the purpose. In Table X is shown the percentage of students, by grades, who failed to work correctly each of the problems which comprise that test. Since ample time was allowed for students to complete the test, it is assumed here that problems not attempted and problems solved incorrectly were both a clear indication of difficulty on the part of the student. It is, of course, possible that some individual students were exceedingly slow and for that reason failed to work some problems which they would otherwise have been able to solve. It should be noted, however, that practically all students stopped working on the test before the time allowed for the test had been exhausted.

TABLE X. *Percentages of Error or Failure on Each of the Problems in the Buckingham Problems Test*

Problem	Grades VII	VIII	IX	X
1	73	70	41	44
2	56	30	22	17
3	52	52	36	26
4	46	55	41	38
5	78	67	54	48
6	78	70	54	51
7	81	65	57	44
8	90	84	56	43
9	100	92	87	77
10	93	91	80	71
11	92	91	79	71
12	90	90	84	65
13	98	97	93	92
14	98	91	83	68
15	95	90	87	86
Total No. Pupils	65	70	111	96

One may read in this table that 73 percent of grade VII failed to solve problem number one. This analysis of students errors or difficulties in problem-solving, as presented in *Table X seems to indicate that the low scores may be due to a sort of general disability in problem-solving more than to their inability to solve particular types of problems.* In grades seven and eight, ninety percent or more of the students failed to get the problems above the eighth. Seventy percent of the students in those grades failed to work the first problem correctly. The high school classes also showed a high percentage of errors.

Similar tabulations to show where specific types of errors or difficulties existed were also made for other tests than the one reported here. The analysis of errors in the Woody-McCall mixed fundamentals test for example showed that problems 32, 33, and 34 provided marked difficulties for students in the seventh, eighth and ninth grades. *The percentages of error varied from 50 to 100 percent on these three problems. They involve multiplication and subtraction of denominate*

numbers and the multiplication of a mixed number by a decimal number. In this way specific types of errors and weaknesses are disclosed for remedial treatment. How important it is for teachers to make such tabulations of students' difficulties or errors as a basis for the corrective or remedial instruction is easily understood.

III. The Plan of Procedure for Improving Instruction Results

By such a diagnosis as has been reported and discussed here various facts pertaining to the teaching situation in a subject may be disclosed. The facts in themselves furnish only the starting point for corrective treatment or for more effective instruction. When specific problems pertaining to the instruction needs in mathematics have been made evident, it is then exceedingly important that suitable remedial or corrective treatment should actually follow the diagnosis and that other suitable steps should be undertaken for capitalizing the information thus made available. Little or no improvement of instruction need be expected as a direct consequence of merely giving tests and tabulating results. But significant outcomes may develop from analyses and interpretations of achievement scores in the various phases of a subject growing out of the tabulations as a starting point.

The situation which has been disclosed by the diagnosis thus far may invite such questions as, "What should be done about it?" "What procedure seems to be warranted by the facts made available that the most effective instruction may result?" "What has been disclosed by the diagnosis that may be of direct value to teacher and student?"

Capitalizing Interest and Achievement of the Students— The plan of procedure employed in this study for the improvement of instruction in arithmetic placed considerable emphasis on informing the students of the exact situation, thereby producing a stimulating effect on them, arousing their immediate interest in these activities and giving them a definite purpose of doing more effective work. It was assumed that the chief factor in the improvement of instruction in any subject may frequently be the arousing of students to feel more concern about their achievement, more interest in their own prog-

ress and more of a purpose to reach desired goals or accomplish definite results. The test scores were utilized for securing this effect.

A complete and detailed statement of the scores in each test was presented to the students in each of the schools as soon as the results had been scored and tabulated. To command the attention of students as fully as possible the presentation was made in the form of wall charts. In this way, students were made as fully aware as possible of their performance as individuals and of their performance by groups. They had an opportunity to compare the achievement of their own class with that of other classes in the same school, and to compare their average achievement in each test with what was regarded as a standard score. The presentation of their own achievement scores to the students was in this way made quite impersonal and objective.

Tables and graphs similar to those used in this report and still others showing complete tabulations of their scores were used in the form of wall charts so that all students concerned were able to see and understand the results both in detail and in their larger bearing. These charts tended to make students aware of the exact situation concerning their work in this subject and to accentuate the importance of their further progress. Some students were also made familiar with their individual scores and the need of further emphasis on portions of the subject in which they were deficient. Thus they tended to develop definite purposes of their own which would guide and stimulate their further work in the different phases of the subject.

While such results were being presented to the students primarily, they were at the same time being presented in a more incidental way to the teachers of those classes who were not only present but interested both in what was being presented to the students and how. The writer of this report, who was acting as supervisor in this connection, presented the charts to the students. The charts were later placed in the possession of the teachers to be used further by them at any time when they might deem their use desirable. The teachers were apparently made quite conscious of the needs of

the situation by what was directly addressed to the students and in only an indirect manner to the teachers. However, the problems involved were later discussed directly with the teachers in conference.

It was not assumed that these teachers of mathematics would forthwith have in mind the whole procedure which should be employed for the improvement of the instruction needs disclosed or for the remedial treatment of particular deficiencies. Merely pointing out to teachers that a need for such treatment exists does not give assurance that they will know with certainty the course to pursue and the steps to employ. Here, if anywhere in teaching, there is need of counsel and guidance. With this thought in mind, *an effort was made to assist the teachers in developing and applying an effective plan of procedure for making the most out of the diagnosis. An outline of suggestions in typewritten form was provided at this point in the experiment for the guidance and assistance of the teachers.* It was an attempt to anticipate some of their practical questions and difficulties in the improvement of instruction.

The outline for teachers consisted of six general divisions and under each of these divisions there were suggestions of a definite or specific nature. It pertained to the selection and direction of both general and special exercises for stimulating students and developing appropriate habits in their mathematical work. It also included emphasis on a continuing diagnosis of the student needs and the repeated measuring of the students' progress. Since the outline which was developed for the assistance and guidance of the teachers formed an essential part of the whole plan for influencing instruction results, a copy of the outline is included in this report.

Outline of Suggestions for Teachers of Mathematics

The efficiency of instruction in mathematics, as in any other subject, must finally be judged by the achievement and progress of the pupils who are taught. The efficiency attained is of direct concern to the school, the teacher, the child and the community. The purpose of this outline is to promote efficiency in the teaching of mathematics. Such an undertaking should involve a clear recognition of the general aims in teaching the subject and also the specific goals or objectives so far as these may be determined. The development of a multitude of specific

habits and the attainment of recognized standards of achievement may be regarded as at least tentative objectives for the purpose of this outline.

It is obvious that one of the chief responsibilities of the school in teaching the simpler phases of mathematics is to engender a large number of specific habits of the right kind. The asertion is sometimes made that this is preeminently the task of the elementary grades, but the engendering of specific habits may continue through the high school and even into college. Moreover, work in the later phases of mathematics is conditioned greatly by the specific habits set up in the study of arithmetic.

The Teacher's Task in Engendering Specific Habits.—The teacher's task in engendering specific habits is complex and varied, but the following general phases may be recognized:

1. Stimulating the pupils to engage in appropriate learning ac-activities.
2. Selecting, devising and assigning appropriate learning exercises.
3. Providing directions, suggestions and standards for the learner in the exercises assigned.
4. Evaluating pupils' performances (diagnosis) for the purpose of determining the effect of the learning activities and consequently their needs for additional instruction or for corrective treatment of the errors diagnosed.
5. Developing in pupils an earnest purpose, continued interest in the work and pride in both their accomplishment and their progress.

I. Stimulating the Pupils to Engage in Appropriate Learning Activities

1. First of all, the teacher should have the learner understand clearly the nature of the particular activity, the objective to be attained and just what responses are to be habituated.
2. In engendering a specific habit it is well to begin with a demonstration by the teacher, accompanied by a sufficiently detailed explanation. Frequently repetitions of the explanation are necesary at succeeding periods.
3. The learner must see clearly what is demanded and feel a direct interest in achieving it. A strong initial desire to form the habit or attain the particular skill will usually be accompanied by more vigorous interest and more continued enthusiasm. Repetition without the proper attitude on the part of the learner is of no avail. This involves a direct responsibility for the teacher.
4. The teacher should make clear to the learner the level of achievement which he is expected to attain, as for example, to multiply 10 exercises of a given degree of difficulty in 8 minutes or to solve 6 problems in a given test.
5. Suitable means should be provided for informing the learner

periodically in regard to his progress in the acquisition of a habit or skill. For this purpose teacher-prepared tests and standardized tests may be used. A few minutes of time for this purpose at frequent intervals will be sufficient if the results are fully utilized. The results should be presented to pupils in both tabular and graphic form. This procedure will give a comparison of the performance of individuals with the group average, of class with class, and of both of these with standards or with their own previous record. The outcome is practically certain to be stimulating to those concerned.

6. The teacher should analyze each unit of instruction to determine the possibilites and needs for engendering specific habits in the learner. Desirable habits are not acquired usually if their formation is left to chance. Definite assistance in this undertaking may be secured from Osburn's Corrective Arithmetic, Streitz's Difficulties in Arithmetic and Their Correctives, Thorndike's New Methods in Arithmetic, Lennes' The Teaching of Arithmetic.

II. Selecting, Devising and Assigning Appropriate Learning Exercises

1. Textbooks in Arithmetic and Algebra are chiefly compilations of learning exercises but teachers may need to employ supplementary textbooks and select or devise many additional exercises from other sources in order that their pupils may achieve the objectives set for them. More repetitions are needed in those responses which prove to be the most difficult. The exercises selected and the methods of instruction employed will usually determine the appropriateness of the exercises.
2. The teacher should earnestly endeavor to have his students understand the need of practice, the function of repetitions, the necessity for concentrated attention, and the importance of "the will to learn." It is well to require at least a portion of the practice under a time limit.
3. A variety of procedures and devices should be employed that the learner may maintain an attitude of interest and that the repetition of practice may not become monotonous.
4. The physical conditions of the classroom should be kept *favorable at all times to learning activities*, with the best light possible, a circulation of fresh air and a constant temperature of 65 to 70 degrees.
5. The teacher should provide for a proper distribution of practice in developing specific habits, skills or attitudes. It is usually held that relatively short and more frequent practice periods bring the best returns for a given expenditure of time. The proper length of the period depends upon several factors, among

which are (a) the maturity of the learner, (b) the nature of the learning activity, and (c) the degree of habituation to be attained.

6. The recognition of a definite need by the learner is the basis of a strong motive for learning. Consequently learning is often most economical and most effective when it results from actual use or when habits are developed in the way in which they will be used, but there is little justification for acquiring a habit until near the time for its use.

   This principle implies the urgent importance of relating the instruction in mathematics directly to shop work, home accounting, community industries, projects in agriculture, and group games, frequently by having pupils or the instructors in other subjects provide such problems for practice in the mathematics classes.

III. Providing Directions, Suggestions and Standards for the Learners in the Exercises Assigned

1. Directions and suggestions which are presented by the teacher should be considered beforehand with special regard to definiteness, clearness and completeness of presentation rather than given in what is sometimes a confusingly impromptu manner. Both clearness and economy may be secured by such preparation on the part of the teacher.

2. The teacher should direct the learner's attention to associations among the facts involved in what he is asked to learn or do. This principle applies both to unfamiliar procedures and to the solution of problems. He needs to know from experience or otherwise about the facts, or content involved in a problem before he can solve it intelligently.

3. After the pupil understands the response that he is to make, the standard of achievement or excellence which is expected of him should also be made clear—sometimes even emphatic. Exercises should be provided for continuing the learning to the required degree of efficiency. Under-learning is always unsatisfactory and often is no better than no learning.

4. The standard of absolute accuracy in computation (100 percent) should be insistently emphasized as the goal desired. While we learn to do a thing right by doing it right, we make no progress toward correct performance by any amount of careless, thoughtless, indifferent repetition. A 100% Club may be formed in any school by pupils who reach or closely approach that degree of accuracy in their computations over a period of perhaps a month.

5. Superfluous habits should be avoided in their computation work, and if acquired they should be eliminated as soon as possible. A very common violation of this principle is the practice of a

pupil in arithmetic who counts on his fingers when adding. Another objectionable habit is "vocalizing" (saying with the mouth) every number or step when doing what is supposed to be silent work in arithmetic. These habits, of course, slow up his mental processes materially and prevent his ever attaining satisfactory proficiency in the operation.

6. Pupils should be made aware of suitable rate standards in simple computation work and assisted to achieve such standards. It is not necessary nor desirable that speed be attained at the expense of accuracy, but it is an established fact that pupils who proceed slowly in practice are usually careless or inaccurate as well as slow—they apparently feel less urge to apply themselves in vigorous fashion.

7. Many istruments are already available for training and testing pupils in the development of standards in rate and accuracy, which may be used to great advantage by teachers and pupils such as—

   Courtis Practice Tests in Arithmetic
   Studebaker Practice Tests in Arithmetic
   Wisconsin Inventory Tests in Arithmetic
   Monroe Diagnostic Tests in Arithmetic
   Fowlkes-Goff Practice Pads in Arithmetic
   Rugg and Clark Practice Tests in Algebra
   Monroe Diagnostic Tests in Algebra
   Douglas Diagnostic Tests in Algebra
   Greene-Studebaker-Knight-Ruch, Remedial Exercise Cards in Arithmetic

IV. Evaluating Pupil's Perforances (diagnosis) Is Important for the Purpose of Determining the Effect of the Various Learning Activities and the Consequent Needs for Additional Instruction or for Corrective Treatment of the Errors Disclosed

1. The efficiency of instruction must usually be judged by the effects produced. This will require frequent and varied use of tests of the objective type. In this way pupils and teacher may also be made aware of their success.

2. One must discover the strong and weak elements in the work of the group and of the individual in order that one may proceed intelligently to give constructive emphasis of the kind and amount that is needed. This implies measurement of rate, accuracy, fundamental processes, reasoning, reading and interpretation, handling formulae or equations, etc.—with perhaps a detailed analysis of the errors which occur in each type of test.

3. The teacher will find that in his book "Corrective Arithmetic" Osburn tells how to diagnose errors in addition and in each of

the other fundamental processes. He also indicates the type errors which are widespread and constant. This is well worth studying for its practical suggestions.

4. Difficulties in solving problems frequently result from language difficulties in reading them. Children should know the meaning of all words and sentences employed before they are asked to solve it. Osburn reports that "at least one fifth of the trouble which children have with reasoning problems is due to inability to read the problem." The pupils will continue to need help with the words encountered which are not in their reading vocabularies.
5. If improvement ceases in any element of the work before a satisfactory level of achievement is attained by the pupil, he should be made aware that his limit of achievement has not been reached and his efforts enlisted in his own further improvement, if possible.

IV. DEVELOPING IN PUPILS AN EARNEST PURPOSE, CONTINUED INTEREST IN THE WORK, PRIDE IN THEIR ACCOMPLISHMENT AND IN THEIR PROGRESS.

1. In endeavoring to secure a learner's continued and persistent effort to learn, the teacher may employ emulation, that is, show him what others have done, but it is doubtful whether a teacher can do any other thing which will so stimulate a learner to greater effort as keeping him informed of his progress in successive performances.
2. The teacher constantly should bear in mind that feelings of pleasure or satisfaction on the part of the pupil facilitate progress in learning. Feelings of pleasure should be associated with successful responses through receiving appropriate commendation. Develop the pupil's pride in his progress and ability to use numbers. He will consequently tend to feel dissatisfaction with a poor achievement record.
3. When a group or a succession of habits are to be formed a psychological rather than a logical order should prevail. This nenecessitates the omission or postponement of the more unfamiliar or difficult types and a regard for the pupil's interest may do much to maintain the pupil's continued effort.
4. Both in drill exercises and in problem-solving a large motivating element may be introduced by means of games and the game attitude. Suitable games may be used effectively to stimulate the learning and to displace much of dull drill. They furnish variety and an element of enjoyment as well, but they should involve all of the pupils and actually stimulate their desire to make progress. The employment of pictures for making problems more real to students is also a practical form of motivation.

5. It is frequently effective to have pupils themselves set up tentative goals to be reached in a week, a month or a semester. Group emulation or rivalry between groups may be employed in this connection.

It is the part of wisdom and economy for a school to provide its teachers of mathematics with all necessary reference books and to hold the teachers responsible for using them effectively. Likewise professional magazines and supplementary teaching equipment may constitute so valuable an aid to teaching efficiency as to constitute an essential investment for the school.

VI. Suggested References

The following books and articles are especially called to the teachers' attention to be used in connection with this outline.

1.—Difficulties in Arithmetic and Their Correctives—Bul. of University of Illinois, No. 34, 1924.

2.—An Analysis of Pupils' Errors in Fractions, R. L. Morton—J. E. R. 2-'24.

3.—Overcoming Some Addition Difficulties, H. L. Ballenger, J. E. R. 2-'26.

4.—Insight in Arithmetic, E. R. Hamilton, J. E. R. 9-'25.

5.—Diagnostic Studies in Arith., G. T. Buswell and Lenore John, Monograph No. 30. Dept. of Educ., Univ. of Chicago.

6.—Pupils' Errors in Solving Arith. Problems, R. L. Morton, Ed. Res. Bul., Ohio State Univ. 4-16-'25 and 4-29-'25.

7.—Corrective Arithmetic, W. J. Osburn. H. M. Co.

8.—Arithmetic Work Book, Grade 7, Teachers Edition. Knight, Ruch and Studebaker.

9.—New Methods in Arith., E. L. Thorndike, Rand, McN. Co. 1921.

10.—How to Make a Course of Study in Arith., M. E. Herricott, Bul. Bureau Educ. Research, Univ. of Illinois, 1925.

11.—Using and Interpreting Standard Tests, H. A. Greene, Bul. Univ. of Iowa, 1-'26.

12.—Improvement of the Written Examination, G. M. Ruch. Scott, Forsman Co.

This outline was first placed in the hands of the eight teachers who were presumably participating in this study, to be carefully read and criticized by them. An opportunity was given to the teachers later to raise questions, offer criticisms or suggest modifications which occurred to them. A list of supplementary articles and books pertaining to the content,

methods and treatment of arithmetic as a subject of instruction was provided for the use of the teachers in connection with this outline. The outline was not imposed upon the teachers but was adopted by them for at least a trying-out.

The Cooperation of Teachers—Further assistance was made available for the teachers by providing them with material needed in carrying out some of the games or practice exercises which had been suggested for the purpose of promoting speed, accuracy and the spirit of enjoying various forms of mathematical computation. For a similar purpose complimentary copies of the Fowlkes-Goff practice pads in arithmetic were distributed for the reference and use of the teachers. The existence of other practice materials was called to their attention in the outline. The suggestion was offered also that if such prepared exercises seemed to the teachers to meet some of their needs for practice material, the school board might well consider it a practical teaching economy to provide the necessary equipment of that sort for the teachers' use.

The extent to which the outline suggestions were actually employed by these teachers was a matter of significance and interest. To provide such information, periodic reports were requested from the teachers indicating which of the activities or procedures suggested had been employed by them, also with what purpose and with which groups of students. *The reports from the teachers indicated that a mjority of them attempted in a serious way to make use of many of the suggestions which had been offered in the outline or at least they claimed to have done so.* The reports from three of the eight were not convincing. Other facts tended to reinforce the impressions that the cooperation of some of the teachers was not actually wholehearted and genuine. Their cooperation seemed to be incidental and quite subordinate to their usual formalized routine. This fact has a bearing on the outcome of the experiment which is presented in another part of this report.

The following list indicates the extent to which the teachers claimed that they had applied the various suggestions offered for their use. The numbers in parentheses show how many teachers said that they had employed the activity indicated.

1. Use of tables or graphs for relative achievement of pupils (5)
2. Special practice exercises (7)
3. Class or group contests (4)
4. Display of superior work (3)
5. Standards or norms in test results (2)
6. Opportunities for practical applications. (Shop, Home, Field Trips, etc.) (2)
7. Use of arithmetic games, etc. (2)
8. Keeping individuals informed as to their actual progress in speed, accuracy, reasoning, etc. (5)
9. Pictures to stimulate interest in problems (1)
10. "Hundred percent" clubs or lists to arouse pride in accomplishment (2)
11. Use of supplementary textbooks (5)
12. Frequent short practice periods to develop or improve skill (4)
13. Attempts to diagnose difficulties or employ remedial treatment (4)
14. Other activities (2)

The interest, approval and cooperation of the teachers in this study were invited at each step in the carrying out of the whole experiment. Immediately following action by the boards of education and the superintendents of schools approving the cooperative study which had been proposed to them, the teachers were consulted to secure their consent to participate in such a study. The purposes of the study, the scope, and the method of procedure were discussed with the teachers who were concerned. *For the most part the teachers displayed an actual readiness to participate in the study and later gave evidence of doing all that could be expected of them at each step of the work.* None of the teachers voiced any objections to such a study. But that some individual teachers seemed to cooperate in an indifferent way has already been stated. This fact naturally tended to have its effect on the outcome of the experiment.

Further Assistance to Teachers—Other steps taken to assist teachers consisted in bringing to their attention some of the essential features or suggestions contained in selected article on arithmetic which were especially stimulative or which might not otherwise have come to their attention. To accom-

plish this, extracts or a condensation of an article was prepared and copies made available for teachers. One abstract and one extract will serve to illustrate this practice.

INSIGHT AND SKILL IN ARITHMETIC

(Adapted chiefly from Journal of Educational Research, Sept. 1925.)

In the testing of arithmetical abilities it is usual to discriminate between "mechanical arithmetic" and "arithmetical reasoning." The practical advantages of such a procedure are evident. But it is desirable that a pupil employ reasoning to a considerable extent in calculation and it is possible that the pupil will depend too much upon mere habit in solving problems. That is to say, many so-called "mechanical" calculations may be really problems for the pupils and many of his so-called "problems" may be really mechanical calculations.

The most important part of the process of problem solution consists in obtaining a clear "insightful" grasp of the situation. E. R. Hamilton says that the two most important tasks of the teacher of arithmetic are (1) that of developing arithmetical insight and (2) that of getting the pupils to enjoy the value of arithmetical work. Dr. H. A. Greene expresses the idea somewhat differently when he says that the two most important tasks are (1) that of increasing the skill with which pupils use the fundamentals and (2) that of increasing their knowledge of when to use them.

A problem is a situation which one should react to intelligently and with the employment of insight. If the pupil does not react intelligently, even though he gets the "right answer," he has not solved a problem. In a recent publication C. B. Upton writes that a good deal of this "problem solving attitude" can come from the right method of handling and thinking about the fundamental operations themselves. But the problem must refer to a situation which is sufficiently familiar to the pupil for him to be able to realize the full significance of the data and to see clearly what it is that he has to find out.

Two or three illustrations may suffice to point out the distinction between formal and rational calculation. For example, rational calculation might proceed in the addition of 57 and 38 as follows:

$$(57+40)-2=95.$$

Likewise, $1340-980=340+20$ (the amounts by which the one exceeds and the other falls short of 1,000) $=360$. Again, $7+3+5+2+3$ may be added as $10+10=20$. These methods may be called rational only to the extent to which there is invention or insightful approval in our use of them.

Many elementary and high school students will develop a marked interest in the variety of method and economy of thinking involved in such procedure if given a fair opportunity to develop some skill in rational calculation. Pupils sometimes come to the instructor to ask how they may improve their scores in this or that phase of the subject when they come to see that some improvement is needed. So long as their interest in their own or their group progress is actively main-

tained the danger is avoided of having pupils regard themselves as failures or of becoming more fixed in their habits of failure. Two or three periods of five or ten minutes per week devoted to rapid and varied practice in calculation may seem to work wonders in the results produced.

So many teachers seem to feel that anyone can employ drill procedure even without the need of any careful thinking, planning, special adaptation or evidence of its effectiveness, that the following extract pertaining to drill in the fundamental processes was made available to the teachers because it seemed to merit their consideration. Eleven characteristics of effective drill were listed by Cassie B. Burton, (Fifth yearbook of the Dept. of Elementary School Principals, p. 323) as follows:

THE EFFECTIVENESS OF DRILL

1. Drill must fit the needs of the class. These needs are to be determined by standard tests, by observing the pupils at work, and by having them do some work orally.
2. The pupil must understand what he is doing, why he is doing it, and the best method of doing it.
3. Drill should be on one element at a time.
4. Good drill keeps all of the pupils busy all of the time during the drill period.
5. Good drill presents the same element in a variety of ways; it appeals to several senses.
6. Attentive repetition is necessary; there should be a maximum of attention.
7. Drill periods should be short and at frequent intervals.
8. Care should be taken that bad habits are not being formed.
9. Good drill lines up with the instinctive tendencies of the pupil—the desire to excel former records, group rivalry, play, etc.
10. Good drill provides for individual work rather than concert work.
11. Drill is more effective under timed conditions.

To give the teachers who participated in this study ready access to some of the recent books on the teaching of arithmetic, several books were purchased by the supervisor for this purpose. This step would have been unnecessary had each school provided adequate professional literature for the guidance and reference of its teachers. The books included The Teaching of Arithmetic, by N. J. Lennes; The Teaching of Arithmetic, Paul Klapper; New Methods in Arithmetic, E. L. Thorndike; Corrective Arithmetic, W. J. Osburn; and Arithmetic Work Book, grades 6 and 7, Teachers Edition, Knight,

Ruch and Studebaker. It would doubtless have been valuable to have discussed certain features of these books directly with the teachers but there was no opportunity for doing so.

That some of these teachers came to the University on a Friday evening or a Saturday morning to examine various tests or to discuss some features of their work seems significant since such action was voluntary and apparently prompted by their desire for assistance. It is encouraging to find teachers not only willing to accept, but anxious to receive assistance of a supervisory nature.

An effort was made to keep the interest of the student in his improvement alive throughout the period of this experiment. In order to vitalize his efforts in that direction occasional supplementary tests were employed and the results presented to the students to arouse, encourage, or challenge them. Furthermore, the teacher was urged to keep the students conscious of their own responsibility to increase their rate and accuracy with reference to all of their computation work.

Many visits were made to the school by the writer and his assistant. Visits to classes, conferences with teachers and with principals received attention. The discussion of specific problems relating to their work was frequent, but probably less frequent than would be likely to happen if the same supervisor were attached to the school system and available at all times.

It is difficult to indicate the exact nature or the detailed features of a conference since conferences tend to vary in content, length, and procedure. *But the chief emphasis was upon assisting teachers to recognize their problems and upon making them feel our readiness to share in the solution of their specific problems or difficulties as well as in dealing with the more general ones.* Definite questions were raised by the teachers or were proposed to them. Some of the questions discussed pertained to the content of instruction, some to methods of procedure, and others to the achievement of individuals or of groups of students.

IV. The Outcome of the Experiment

The proof of value in any undertaking or experiment may usually be found in the outcome. Some of the results of this

experiment which seemed real and valuable were not measured because of the difficulty or inability involved in measuring them. Other results were more readily measurable and some of these are presented in tabular and graphical form in this portion of the report together with brief explanations of them. Some of the results are gratifying but not all are equally convincing.

The tests which were given in November were repeated the last week in April or the first week in May. *Approximately five months intervened between the completion of the first testing period and the final testing.* As different forms of the test were employed in the later testing they represented similar difficulty, but not identical content. The mental group test was not repeated since it was not deemed necessary to repeat that test considering the purposes for which it was employed.

While the gain in scores shown was definite and marked in several of the tests it was by no means consistent or uniform in all of the tests. *In general, more tendency to improve was shown and a greater gain in score was made in the seventh and eighth grades than in the ninth and tenth grades.* In Table XI the difference between the median scores in the November and May tests is shown for each of the four classes tested in the Courtis test in arithmetic.

TABLE XI. *Comparison of Median Scores in November and May. Courtis Test in Fundamental Processes*

Grades	VII	VIII	IX	X
Addition				
November	4.0	5.5	5.2	5.5
May	4.6	4.9	6.2	5.5
Subtraction				
November	6.0	7.0	8.0	8.8
May	7.5	8.3	7.6	9.4
Multiplication				
November	5.0	5.8	5.1	5.4
May	5.5	6.	5.1	6.1
Division				
November	3.	4.2	4.9	6.3
May	4.1	4.5	4.2	5.5

The median scores in the May test exceeded those in the November test in nine of the sixteen grade records reported in Table XI. In two instances the median score was not changed and in five instances the median score in May was less than the median score in November. *In only four of the sixteen comparisons reported in this table was the gain in median score as great as one problem.* The amount of improvement made by these classes in the various divisions of the Courtis test does not seem to be very great or consistent.

The increase in median scores in accuracy in the Courtis test was much more encouraging than was the gain in the rate of computation. The seventh grade class made gains in the several divisions of this test ranging from seven to nineteen percent. The average gain made by the seventh grade in the four divisions of the test was fifteen percent. The freshman class in high school showed a consistent gain in accuracy scores but the gain was much less than that made by the seventh grade. The average gain in accuracy made by the freshmen in the four processes tested was six percent. These facts are shown in the table which follows:

TABLE XII. *Gain in Accuracy Scores—Courtis Test*

Grades	VII	VIII	IX	X
Addition				
November	44	54	55	62
May	59	59	62	61
Subtraction				
November	69	73	71	76
May	77	76	77	79
Multiplication				
November	47	60	50	57
May	66	67	63	64
Division				
November	56	63	72	71
May	71	73	76	80

It is an interesting fact, and one worthy of note at this point, that the increase in accuracy scores alone which these students made during this five months' period would have given larger scores in number of problems worked in May without any increase in their rate of computation over the

rate in November. For example, in the multiplication test the seventh grade class showed a gain in its median accuracy score of 19 points. This gain of 19 points was made on a score of 47 percent in accuracy in the November test. The increase of accuracy was thus 40 percent (19 divided by 47). The seventh grade class had made a median score of five problems in multiplication in the November test. That meant five problems right out of eleven problems attempted. *The increase in median accuracy score made in that grade in the May test should have given an average score of seven problems correct on the basis of the same number of problems as were attempted in November. As a matter of fact the median score of the seventh grade in May was not so much as seven problems, but only 5.5 problems.*

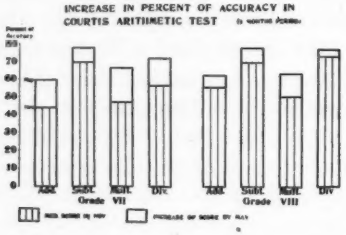
Similarly, the eighth grade, on the basis of its increased accuracy alone, should have worked 6.5 problems on the average in the May test. In fact, the median score of that class was only six problems. The freshman class, on the basis of its improved score in accuracy, but with the same rate of computation, should have had a median score in May of 6.4 problems in the multiplication test. Its median score in May was only 5.1 problems. Thus the evidence accumulates that the improvement in accuracy of these classes in the Courtis arithmetic test was accompanied by a slower rate of computation. There is no information at hand to indicate whether the teachers urged it or the students were directly responsible for the slower rate of work as they secured this greater accuracy. *But in view of the fact that these students had previously appeared both slow and inaccurate in their computations, it seems unfortunate that the accuracy score was not increased without a decrease in the rate score.*

The increase in accuracy scores are shown in Chart V for the seventh and ninth grades in each of the four divisions of the test. It is a striking fact that such great increases in accuracy as are shown in the chart could be secured in so brief a period and apparently in so incidental a manner.

In the Woody-McCall test the greatest gains were made by the seventh and eighth grades as is shown in Table XIII. As an average gain of 1.7 problems represents a year of progress

in this test (see Table VI) *the gain in score made by the seventh grade students (4 problems) was equivalent to more than two years of progress. The gain in score in grade eight*

CHART V



(2 problems) was equivalent to more than a year of progress as measured by this test. The ninth grade made only a slightly higher average score than in November.

CHART VI

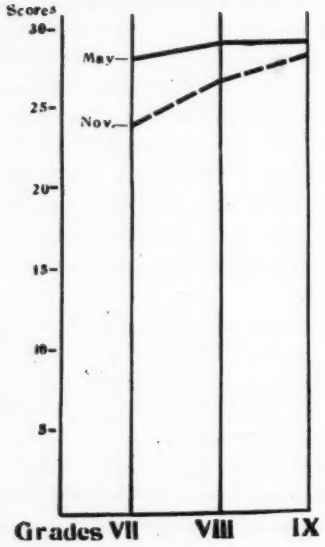


TABLE XIII: *Increase in Median Scores in Woody-McCall Test*

Grades	VII	VIII	IX
November	24.3	27.	28.4
May	28.3	29.	29.2
Gain in score	4.	2.	.8

In several other Kansas schools of similar size the average progress made in a year by the same grades in the same test was represented by a score difference of less than one.

These facts are shown graphically in chart 6.

The May scores in the Buckingham problem-solving test were distinctly higher for each of the four grades tested than were the November scores.

The average increase of score for these grades ranged from 1.4 to 3.1 problems. Bearing in mind that an average gain of two problems represents a year of progress as measured by the test, it is evident that *the increased scores shown in the following table for a five months' period represent the equivalent of more than a year of progress for two of the grades and about three-fourth of a year for the other two grades.*

TABLE XIV. *Increase of Median Scores in Buckingham Problem Test*

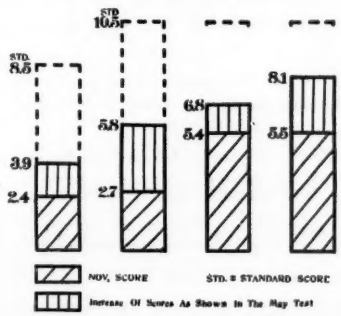
Grades	VII	VII	IX	X
November	2.4	2.7	5.4	5.5
May	3.9	5.8	6.8	8.1
Increase in score	1.5	3.1	1.4	2.6

The scores in this test which are available from other schools in the state indicate an average yearly progress of slightly less than one problem for each of the four grades except the seventh—in which the progress was nearly two problems. By comparison with such increase of scores, the progress shown by grades in table XIV tends to invite attention. The gain in score made by the different classes in this test is made evident in chart 7 which portrays the same facts as those shown in Table XIV.

CHART VII

Increase In Median Scores

BUCKINGHAM PROBLEMS TEST



In Chart VII the columns, reading from left to right represent grades VII, VIII, IX and X. *It is apparent that the*

students in Grade VIII more than doubled the average score which they made in the initial test. The standard score for eighth grade may also be treated as a tentative standard for grades nine and ten.

The reading test scores for the seventh and eighth grade classes likewise indicated a marked increase of scores during the period of this experiment. The increase made by each of these classes was equivalent to almost a year of progress in reading as measured by this test. However, the ninth grade, to which the Van Wagenen reading test was given, showed no progress in reading as measured by the test. The median score in May was the same as the median score in November. Thus it appears that if the ninth grade made any progress in ability to read during the five months' period, it was not disclosed by the Van Wagenen reading test.

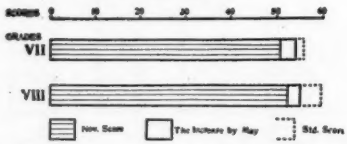
TABLE XV: *Comparison of Reading Test Scores in November and in May*

Thorndike-McCall Scale			Van Wagenen Scale
Grades	VII	VIII	IX
November	51.0	52.8	13.8
May	54.3	55.8	13.8
Increase in scores	3.3	3.0	

Even the progress which was made by the eighth grade brought its median score up only to approximately the standard score for the seventh grade. The relation of the class medians to the standard scores of the two classes which took this reading test is shown in the graphical representation in chart 8.

CHART VIII

Increase Of Median Scores In Thorndike McCall Reading Test



When the Hotz algebra test in addition and subtraction was repeated in May the median score (5.6) was only slightly above the average score in November. This means that the

median score after eight months' study of the subject was considerably below the nine months' standard score in the test (which is 7.9). *It appears that as the ninth grade students advanced in the study of algebra they made practically no improvement in their ability to perform computations in addition and subtraction. Likewise in the multiplication-division test and in the equation-formula test in algebra these students were markedly below the standard which is expected at the end of a year's study in that subject.* As the two last named tests were not given in November it is not possible to report the progress made in those phases of the subject during the five months' period.

The progress of the sophomore class as measured by the Rogers test of mathematical ability is reported in Table XVI. *It may be noted that definite progress was made in each division of this test.* Especially do the score values, secured by weighting scores in the several test divisions, indicate a marked increase in the achievement of the sophomores as measured by the Rogers test.

TABLE XVI: *Comparison of Average Scores in November and May in Rogers Test.*

	Nov. Score	Score Value in Nov.	May Score	Score Value in May
Geometry	10.0	80	18.6	149
Algebra	11.0	66	15.6	94
Superposition	19.0	57	27.5	72
Language	11.0	66	17.0	102
Mixed Relations	23.0	46	28.3	57
Interpolation	53.0	53	75.0	75
	127.0	368	182.0	549

Comparing the total of score values in this test in May and November, one finds that the increase in score values (181) is approximately fifty percent of the total of score values in the November test.

Increases in Scores Were Independent of Eliminations—A total of more than 60 students who were tested at the beginning were not present for the tests at the end of the experi-

ment. In comparing student achievement in May and November the differences would have appeared greater if the median scores had been computed for the entire group of students tested in November. This was not done, but the same students and the same number of students comprised the groups for which median scores have been reported at the beginning and end of the experiment. This means that the students who dropped out of school before May or who for some other reasons did not take a given test in May were not included in the November tabulations when making comparisons of score increase. If their scores had been included the averages in November would have been lower in several of the tests and the increase of score by May would have appeared considerably greater.

It happened that the students who were eliminated from the later tests had made lower scores in November in most of the tests than had those students who continued and took the later tests. For example, *the median score of the eliminated high school freshmen was four points lower in the Van Wagenen reading test, one point lower in the Woody-McCall arithmetic test and nearly one problem lower in the Buckingham problem test than the median scores in the same tests for the continuing portion of the class.* In the Courtis arithmetic test the freshmen eliminated had a lower rate score of 1.5 and a lower accuracy score of 10 percent than had those not eliminated. *To have treated this gain in average achievement due to elimination as though it had been due to improved instruction would, of course, have been unwarranted.*

This apparent tendency toward selection in the type of student eliminated between the two testing periods applied also to the other grades. But since half of all the students lost from the four grades were freshmen the facts for that grade alone are reported here. *The point particularly involved is that none of the increase in the median scores reported in this study were due to the elimination of weaker students.*

Other Outcomes May Not Be Shown in the Scores—The effect of the procedure employed in this experiment upon student and teacher attitude may actually represent one of the most important of the outcomes, yet it is extremely difficult

to prove by objective measurement that such is true. It is also possible that the effects sought would have been cumulative and much more apparent if the experiment had continued over a longer period so as to have provided more opportunity for the students in modifying old habits and forming new ones. Perhaps, too, the procedure employed would have been even more effective if employed in grades below the seventh. In other words, it is probable that not all of the significant features of this experiment have been measured.

Summary of the Study

1. An experimental study pertaining to the improvement of instruction in arithmetic was undertaken by the writer, who acted to a limited extent as a supervisor. The school grades from seventh to tenth inclusive and including a total of 357 students in three small school systems were involved in this study.

2. An initial program of mental and achievement tests was followed by a rather definitely planned procedure extending over a period of five months. A final testing program served to indicate the extent of improvement made by these students.

3. A limited diagnosis of the situation pertaining to instruction in arithmetic was based largely upon an analysis of the scores. The diagnosis pertained to such considerations as mental ability, previous schooling, achievement in various phases of the subject and specific types of errors or difficulties which characterized the students' work.

4. The students concerned in this experiment seemed quite typical in mental ability of those found in other high schools of similar size in the state.

5. Rather marked deficiencies were disclosed on the part of these students whose scores were compared with standard scores in both rate and accuracy in the mechanical computations as well as in problem-solving ability.

6. The students who had received a majority of their elementary schooling in rural schools made lower average scores in several of the achievement tests used. Apparently this fact constitutes a special problem of instruction for the high school teacher of mathematics.

7. The analysis of errors made by students in these tests disclosed some specific types of weakness in which there was need of remedial treatment.

8. "The facts" disclosed by the tests were presented directly to the students to stimulate, challenge, or give definite purpose to their efforts toward self-improvement in this subject.

9. An outline providing general and detailed suggestions was prepared for the use of the teachers in their efforts to improve the achievement of their students. Other assistance was also provided for the teachers especially in the form of conferences and abstracts of selected articles in current literature. The cooperation of the teachers was for the most part gratifying and encouraging.

10. The increases in average achievement scores were more consistent and marked in the seventh and eighth grades than in the two more advanced grades. The average increases in computation rate were slight but in accuracy of computation the increases were significant. Some increases were 40 percent of the average score made in the initial test. All of the grades made a good increase in average score in the problem-solving test. Grades seven and eight made a year's progress in reading in the five months' period. The sophomore class made gains in the Rogers test equal to 50 percent of its initial test score, but the freshman class made practically no improvement as measured by the one algebra test which was employed.

Bread Training School

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DIAGNOSTIC TESTS AND REMEDIAL MEASURES FOR THE TEACHING OF ENGLISH IN THE HIGH SCHOOL

* * * * * *

By

Lou L. LaBrant
Supervisor of Teaching of English in the
Oread Training School

In the elementary grades spelling, handwriting, reading, composition (language) and dramatization are introduced as individual subjects. With the beginning of the ninth year, these lines have converged, and, with new elements added, are known as "English". In an effort to simplify the teaching problem presented by such a combination, many high schools in Kansas have now separated the study of composition (oral and written) from the study of literature. Even so the situation is complex.

Not only does the child have varying abilities for several units which make up his equipment for the use of language, but this variability has been increased through unequal emphasis in his teaching. His spelling may have been neglected; he may have been allowed to write carelessly; form may have been presented as the chief goal in writing themes. Two students from the same eighth grade may present themselves for entrance to the ninth grade class with identical grades, although the two individuals are equally skillful in none of the necessary elements of their training.

Moreover, these skills, acquired in spelling, penmanship, and reading classes, affect one another, disguising the real nature of the pupil's difficulty. We are discovering through experiment that pupils conscious of marked spelling disabilities are inhibited by these difficulties until they frequently develop an unnaturally limited style in written composition. That such students have also developed a dislike for written composition may be expected. We have yet to discover whether handwriting affects skill in composition, but many teachers of English have noted that the boy whose writing is cramped tends to produce brief and inadequate compositions, although his natural tendency to wordiness may be apparent in conversation. Length of the pupil's comprehension unit in reading--word, sentence, paragraph--often determines his ability to understand literature, and consequently may modify his emotional reaction to what he reads. To determine why a student does poor work in an English class is a complicated problem.

(2) The teaching of English continually modified by extra-class room experience. It is safe to say that achievement in no other subject

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Diagnostic Tests and Remedial Measures for the Teaching of English in the High School

In the average Kansas high school no brief is necessary for defending the value of a testing program in which pupil scores are compared with certain standards or norms for the purpose of measuring success in teaching. Many schools, however, have limited their use of standardized tests to the discovery of the one item, relative achievement. It is the purpose of this paper to outline for the department of English in high school a suggestive procedure of diagnostic testing, intended to discover not only the comparative degree of the child's achievement, but details of his difficulties. Such a method seems t the writer desirable for any department, but the study of the vernacular contains elements which make especially desirable such a pupil-diagnosis as is here presented. Three conditions involved in the nature of the subject matter of an English course emphasize either the probability of pupil differences in a given class, or the importance of definite information concerning those differences.

(1) The English course a combination of varied elements. The study of the vernacular is unique among school subjects in the breadth of its curriculum. In the elementary grades spelling, handwriting, reading, composition (language) and dramatization are introduced as individual subjects. With the beginning of the ninth year, these lines have converged, and, with new elements added, are known as "English". In an effort to simplify the teaching problem presented by such a combination, many high schools in Kansas have now separated the study of

The influence of the home on reading habits, speech, and even writing, is too obvious for mention, were it not that curricula generally give little recognition to this valuable and specific home teaching. The teacher of English finds her understanding of her class constantly complicated by this out-of-the-classroom training. This situation is in itself sufficient to call for frequent diagnosis of abilities and disabilities within a given class.

(3) The effectiveness of the teaching of English dependent especially upon satisfaction of the pupils. The teaching of English is chiefly of value when abilities and information acquired by pupils are translated into life habits. We are no longer content with teaching about books; we now attempt to establish habits of reading. We teach only such formal grammar as is clearly functional, with the evident intent that it shall function. Habits have been accepted as aims. Although satisfaction is generally recognized as an important factor in any learning, it becomes of additional importance in establishing such personal habits as those of speech or leisure reading. Repetition may sometimes succeed in stamping in the multiplication table, even though the satisfaction (or relief) of conquering may be small. Later in life, however, the use of this table will be brought about by economic or other social demands. John may have abhorred the nines, but he will find need for remembering nine times nine. The penalty for not knowing will help him to remember. With certain phases of English a similar condition will maintain, but much of the value of class work will be lost unless the pupil enjoys it enough to wish to repeat the experience.

If the boy hates to read--despises his classics--there is little probability that experience in life will drive him to a study of literature over his protest. The effectiveness of the teaching of English is therefore seen to depend greatly upon pleasant associations in the learning process. Adaptation of the course to the needs of the individual is

of the curriculum is so modified by constant use as is achievement in the use of the vernacular. If the teacher of algebra were to find the performance of his poorer students modified by daily drill involving the incorrect use of signs, he would probably despair; if his better students gave themselves over to an equal number of hours of intensive study under the best of tutors, he might rejoice. It is not probable, however, that he would expect the two groups to finish algebra together after a nine months period of such contrasted training. A similar situation, however, actually prevails in the department of English.

The pupil who is the best student of literature in his class in June is likely to return to school in September with his ability improved by three months of good reading. The poor student, who dislikes reading, returns with no gain, but with a summer's development in the habit of choosing active experiences in preference to vicarious ones. The two are much farther apart than they were at the close of school. This situation is not confined to vacations, though the results then may be more apparent than during the school year. In any department the range of achievement within classes is dependent upon intelligence, interest, and many factors not under the control of the teacher, but this is doubly true in the case of the English class.

The influence of the home on reading habits, speech, and even writing, is too obvious for mention, were it not that curricula generally give little recognition to this valuable and specific home teaching. The teacher of English finds her understanding of her class constantly complicated by this out-of-the-classroom training. This situation is in itself

desirable that the records of students in these tests be available for comparison with, and interpretation of, achievement scores, as a part of the diagnosis, but their administration is usually outside the province of classroom teachers or departmental supervisors.

Standardized tests and scales for English now make possible the rating not only of the pupil's general ability to write, but of his achievement of the elements involved in this general ability. An enumeration of the items in English now specifically covered by standardized tests includes the following:

1. Ability in handwriting.
2. Ability in spelling.
3. Ability to sense completeness of expression (sentence sense).
4. Ability to capitalize and punctuate the sentence after it has been written.
5. Ability to choose desirable words (vocabulary).
6. Ability to compose paragraphs (rated on scales).
7. Knowledge of grammatical terms and rules.
8. Ability to apply grammatical terms and rules.
9. Ability to use words correctly as regards grammatical structure, regardless of knowledge of terms and rules.
10. Rate of reading.
11. Comprehension in reading.
12. Familiarity with classic literature.
13. Appreciation of literature.

Examination of the foregoing classification shows that the teacher who is interested in diagnosis has at hand many excellent tools. Certain of these tests are labeled diagnostic and emphasize the importance of scores on individual items rather than gross scores. For example, by means of the Pressey Diagnostic Test in Punctuation a teacher may discover not only that a given class or student does as well as average pupils of the same grade, but also that the given class or student fails in the application of certain specific rules.

obviously a fundamental means for attaining this satisfaction. The child who is set a task which is either too dificult or too easy is not likely to find it so satisfying that he will carry it forward of his own volition. Careful diagnosis is essential for the teacher who would develop desirable habits.

(4) Diagnosis needed--continuous and detailed. It is evident from a consideration of the foregoing that intelligent teaching of the vernacular in high school calls for a study of the abilities of each pupil in class. This process is probably most necessary when we are dealing with entering freshmen. Because of the usual practice of passing pupils by grades, it frequently occurs that a pupil's deficiency in writing skill may have been given less emphasis in view of his high rating in, let us say, arithmetic. With entrance into high school his merits in any course are considered with less reference to his progress in other subjects. We may expect markedly unequal achievement of individuals entering courses in high school. The program outlined here is therefore especially adapted to ninth grade students, although it should be carried on throughout the high school course for purposes of adjustment and reclassification.

No discussion is given here of the use of mental tests. It is most desirable that the records of students in these tests be available for comparison with, and interpretation of, achievement scores, as a part of the diagnosis, but their administration is usually outside the province of classroom teachers or departmental supervisors.

Recognition Test. This test concerns itself with only one item of punctuation, the end stop. It is primarily interested in discovering whether pupils have a feeling for complete statement. Until this sense is developed there is little likelihood of success in teaching the more intricate elements of punctuation and sentence structure. Failure of the teacher to realize this difficulty may be one cause of the poor results from much of the teaching of composition. The following illustration may emphasize this statement.

In a class of fourteen high school freshmen, all were familiar with definitions of noun, verb, subject, predicate, dependent clause, and independent clause. Of the fourteen, however, six failed to find anything wrong with the expression: "Being utterly unable to go because I had a bad cold." Their attempts at discovery of error included criticisms of the words "bad" and "utterly", and of the reason for being unable to go. All six were satisfied with the completeness of the being phrase. It is doubtful whether abstract ideas of parts of speech, or rules as to their use, can be taught effectively to such children until they have learned to feel the inadequacy of such expressions as the one above. Whether this be true or not, certainly the problem of teaching these students to write is clarified by discovering that they lack this fundamental feeling for a complete statement. Carelessness, too frequently blamed for faulty punctuation, is not the chief difficulty with such pupils as the six here discussed.

As suggested before, it is probably useless to indicate any but gross errors to the child whose written composition is characterized by incoherent and incomplete expressions. To go beyond this, means that so many difficulties will confront him as to result in nothing better than confusion and guessing. Intelligent diagnosis gives a reason for accepting one pupil's paper because he has used periods and capital letters correctly, while another in the same class is required to rewrite a theme because his sentences are too wordy, or too much alike.

Many tests become diagnostic when considered in relation to an entire process. For example, a test in punctuation may reveal the fact that pupils in a class use comma sentences. Until the teacher has discovered whether they have developed a sense of expression--sentence sense--he cannot know whether this failure is due to a fundamental misunderstanding of sentence making, or to the mere incident of failure of previous teaching to stress use of periods and semicolons. The test for sentence sense becomes, therefore, by virtue of its use, diagnostic.

The program described in the following pages has been for three years a definite basis for the teaching of English at Oread Training School in the University of Kansas. The discussion here will divide the tests into two groups: those involving ability to use language for expression (composition), and those involving ability to use language for receiving thought (reading, hearing). Tests valuable for discovering ability in composition are presented first.

II Composition: Diagnosis

(1) Sentence sense. The first step in diagnosing pupil ability in composition is to determine whether or not the child has developed what, for want of a better term, English teachers are calling "sentence sense". An excellent test for this purpose is the University of Wisconsin Sentence Recognition Test. This test concerns itself with only one item of punctuation, the end stop. It is primarily interested in discovering whether pupils have a feeling for complete statement . Until this sense is developed there is little likelihood of success in teaching the more intricate elements of punctuation and sentence structure. Failure of the teacher

It is, however, necessary to include in texts and drill books exercises to cover the difficulties which are most marked the country over. For this reason, a language usage test is most desirable at the beginning of the year, to determine which errors are most deeply rooted. If results of this test are used in connection with an analysis of speech errors which teacher and class may make, based on the actual speech of the individuals involved, an intelligent direction of effort may be made. The Wisconsin Test of Grammatical Correctness or the Wilson Language Error Test is excellent for this purpose. The Language Usage section of the Stanford Achievement Test is also valuable. For several of the later text books such diagnostic tests are included in the teacher's handbook, or are provided without cost for classes using the text.

(3) Capitalization, punctuation, grammar usage, sentence structure. The tests for sentence sense previously discussed involve the use of simple punctuation and capitalization. It is possible that pupils who have not acquired sufficient "feel" for sentence completeness to note the lack of meaning in a phrase or dependent clause should be held to a development of this ability, and given no further work in punctuation until this is achieved. With most high school students, however, the problem of teaching capitalization, punctuation, grammar usage, and correct sentence structure has reached sufficient complexity to warrant the use of diagnostic tests to discover specific weaknesses and abilities in these requirements.

The teacher can save herself and her class much time by discovering which rules are those which trouble the largest number, and which have already been mastered by the class or by individuals. We have now reached a fairly satisfactory state of agreement as to minimum essentials for writing, and have several batteries of diagnostic tests covering these. Among the most satisfactory are Diagnostic Tests in Composition by Pressey and others. These are easily administered, are adapted to individual as well as group diagnosis, are presented in several forms and hence adequate for retesting, and are thoroughly standardized. Other tests, however, are available.

Recognition of individual differences in needs and abilities does not necessarily lead to any unpleasant feeling within a class. Children know that some do better work than others and that the teacher knows it. If attention is called to the pupil's difficulties and achievements rather than to his score, there should be no trouble.

(2) Language usage. An analysis of recently published texts for high school composition leaves no question as to the prominent place given the teaching of language usage in ninth and tenth grade English courses. Recognition of the difficulty experienced by the average student in applying the abstract rules and definitions of grammar to sentences in his speech and writing has changed our procedure markedly. Text books and courses of study now furnish abundant suggestions for the teaching of correct usage through drill rather than analysis. In using them, we attempt to change the child's statement from "I have went" to "Ihave gone" through repetition of the correct form instead of by any application of the rule that one should use the past participle with "have" or "has". It is probbable that this method has much to recommend it, especially when we are dealing with any but brilliant children.

It is obviously a waste of time to assign an exercise designed to correct a bad habit which a class does not have. Errors in speech vary with the schools, the community, and the home from which the child comes. It is, however, necessary to include in texts and drill books exercises to cover the difficulties which are most marked the country over. For this reason, a language usage test is most desirable at the beginning of the year, to determine which errors are most deeply rooted. If results of this test are used in connection with an analysis of speech errors which

Many teachers make objection to such a program as that outlined above on the ground that the time involved in administering the tests is so great as to prohibit their use in the ordinary small school where sectioning is not practicable. At Oread Training School, which has an enrolment of sixty students, the difficulty is met by making the testing a part of the teaching. Before each test is presented, the purpose is clearly explained to the children, who are therefore prepared to assist in the checking and the interpretation of results. One of the most difficult tasks or obligations of the teacher of composition is to secure the intelligent co-operation of the children she is teaching.

Such general objectives as "improvement of your speech,""better composition" or "more accurate sentences" usually fail to interest. As soon, however, as the child has his attention drawn to his own peculiarities, difficulties, and abilities or disabilities, his interest is likely to be secured. In the experiments reported, pupils assist in checking and preparing their own diagnoses. For example, after taking the Pressey tests, each child lists the types of errors he makes, looks up rules covering these in his hand book, and lists the rules. Following this he writes a theme, upon which the teacher indicates errors by checks. The child then identifies the types of errors on his theme, lists these, and compares the resulting statement with the list of errors he has made on the standardized tests. After this, in conference with his teacher, he formulates a statement of his own chief difficulties, and his objectives for the semester's work. All of this usually requires two weeks of work with a sophomore class.

Although ostensibly the students are merely preparing for work, note should be taken of what is really accomplished. (1) The teacher has a detailed, intelligent knowledge of the writing difficulties of her class, and of each individual in her class. These she has had opportunity to consider until they are comparatively well fixed in her attention. In addition she has a written statement of these difficulties filed for convenient reference. (2) Each student has a similar knowledge

(4) Grammar. Grammar tests vary so widely in type, content, and purpose, that it is difficult to present a brief discussion of their uses. Teachers of English have yet to discover a most important thing, namely, how far the pupil's knowledge of formal grammar is applied in concrete situations. A number of tests undertake to discover this through the device of presenting sentences for correction in one column, and rules for application in another; but the very proximity is in itself half an answer. For determining knowledge of the more commonly taught rules we have perhaps no better tool than the Barret-Ryan tests developed at Kansas State Teachers College, Emporia. Either the high school scholarship series of these tests or the series used for college entrance examinations is satisfactory.

(5) Spelling. For testing high school spelling a most satisfactory means is the book of sixteen Spelling Scales. One copy in the hands of the teacher is adequate for testing and frequent retesting of any number of high school classes. High school students who spell poorly are usually so tied with bad spelling habits or specific spelling difficulties that correction is slow. Retesting is therefore desirable.

III. Composition: Remedial Procedure

Many teachers make objection to such a program as that outlined above on the ground that the time involved in administering the tests is so great as to prohibit their use in the ordinary small school where sectioning is not practicable. At Oread Training School, which has an enrolment of sixty students, the difficulty is met by making the testing

If the teacher's classes are so large as to make it impossible for her to keep in mind the individual needs of her pupils, a card index for her desk will solve the difficulty easily. At Oread Training School score cards, filed by classes, are kept for the use of student teachers who are unfamiliar with the needs of students whose papers they handle. The better students in a class may be responsible for keeping these scores recorded, if the teacher finds this work too heavy a task. The scoring and assigning of themes in accord with the objective information secured through diagnosis is a logical part of the resulting procedure.

Diagnostic teaching does not lead to uniform scores at the close of a term. It is the writer's belief, based on careful experiment and checking of scores made on standardized tests, that it does lead almost invariably to marked improvement in the performance of the class as a whole and as individuals. The superior pupil, given opportunity to work on problems suited to his needs, is usually farther advanced at the end of the year than under the ordinary system. Surely this is no calamity, even if his superior performance should result in an added promotion. Surveys of both small and large high schools have repeatedly showed that we have certain students in our freshman high school classes who do better work than others in the senior classes. Uniform standards, disregard of differences, and uniform assignments have not brought uniform results. If the teacher feels that she is unable to judge concerning grades and promotion without a uniform procedure, she may formulate a minimum requirement at the beginning of the course, and base promotions on this as a standard.

Frequent testing and careful diagnosis have resulted in reclassification of Oread students at irregular intervals. A boy who consistently hands in themes correct in form, spelling, and sentence structure, may be taken from the freshman class and introduced to a study of organization in the sophomore class. As stated earlier in this paper, so many factors outside the classroom are constantly influencing the language activities

of his own difficulties, their relation to those of the class as a whole, and a concept of himself as an individual interested in overcoming those inabilities. (3) Each student, through his diagnosis, has become familiar with the material to be mastered and its relation to his own particular problem. (4) As a further result considerable writing has been done by students who think they are merely getting ready to write. If the testing program be thus made a part of the teaching program, its administration need not be expensive in time, nor burdensome to the teacher.

A second objection frequently offered to diagnostic teaching is that it is in reality individual teaching. Whatever may be the case in other departments, the work in English composition must always in its final analysis be individual work. Even those teachers who assign subjects for composition and limit the number of words to be written, do not expect to receive identical themes, nor themes of equal merit. Such approximate uniformity as is found in the solution of a set of algebra problems is an impossibility with a set of student themes. Any activity which involves as intimate a matter as use of language, must take into consideration individual differences. The teacher who does not know that there are pupils in her class at the first of a given semester doing better work than certain others can possibly do at the end of the term, is merely blind to existing conditions. The range of scores on such a test as the Pressey Punctuation Test not uncommonly runs from three or four to twenty-four, for a ninth-grade unselected group.

If the teacher's classes are so large as to make it impossible for her to keep in mind the individual needs of her pupils, a card index for her desk will solve the difficulty easily. At Oread Training School score cards, filed by classes, are kept for the use of student teachers who are

One cause for this failure to develop the reading tastes and habits of students may be found in the older curricula which placed emphasis upon teaching about literature, and teaching how to read rather than upon the establishment of habits. Knowledge of how to read, is, of course, basic to the building of the habit of reading, but there has often been a marked gap between the type of reading material taught in class and the type which could reasonably be expected to appear in the daily reading of the average high school graduate.

A lad with an intelligence quotient of ninety-five may now complete the course in our secondary schools, but if his reading ability, so far as mechanics are concerned, is in proportion to his general mental ability he will never read easily any but comparatively simple books. That he may read these, however, is as easily possible as that he may finish his high school course. The gap between the more difficult classics which he reads under the direction of an instructor and with the assistance of the others in his class (no small assistance) and the books he will find it pleasant to read in later life is considerable. It becomes a part of his high school training, therefore, to establish, or to help him establish, the habit of regular reading along lines which he may reasonably expect to continue. This is, of course, what we are attempting to do through our collateral reading in English literature courses.

To do this intelligently requires more definite information than most of us can acquire without employing objective measures. True, many who have taught for some years have become more or less proficient in gradually learning to diagnose the needs of pupils, provided classes are not too large. But much time is lost in doing this even with the best of teachers and the best of conditions. A boy who is given a book which is toodifficult for him to understand, not only fails to read that book, but has a basis for the belief that he does not like to read, or that he does not like to read books, or perhaps that he does not like to read anything the school or teachers approve. The use of objective tests has enabled

of the individual that it becomes absurd to expect uniform progress. The giving of credit is a matter for administration rather than instruction. It has been the experience of the writer that a student will gladly do work with a second-year class--even though he is to receive credit for first-year work only--if in that class he finds work suitable to his needs. If we remember that the teaching of English is the development of a tool which is the pupil's key to the world, it will be apparent that, given exercises which meet his particular needs, a student--even a boy--will enjoy English--including composition.

IV. Literature or Reading: Diagnosis

Not only teachers of English, but the general public as well (perhaps the statement should be reversed, but for the sake of professional pride it may stand) are recognizing the development of the habit of reading as the chief aim of the study of literature in high school. With increased leisure and enlarged facilities for obtaining many and good books has come the demand that our high school graduates be equipped with habits which will enable them to make the most of the time which they have for reading. That we as teachers of literature have not succeeded in accomplishing this is evidenced by a study of the array of reading matter presented for sale in our cities and towns. The quantity of low grade magazines which obtain ready sale speaks discouragingly of what is accomplished in our teaching of how and what to read.

One cause for this failure to develop the reading tastes and habits of students may be found in the older curricula which placed emphasis upon teaching about literature, and teaching how to read rather than upon the establishment of habits. Knowledge of how to read, is, of course, basic to the building of the habit of reading, but there has often

trial scene from "The Merchant of Venice". A fourteen-year-old, reading Antonio's farewell to Bassanio, said: "Commit me to your horrible wife." The reader will perhaps recognize this as a perversion of the original speech: "Commend me to your honorable wife." When the class laughed the reader was puzzled, although he knew the meaning of both"horrible" and "honorable". He had not, however, been at all distressed at the absurd sentence he had made, because with him reading did not necessarily imply thinking or understanding. His problem is different from that of his neighbor who makes the same final score on a reading test, but who is annoyed at each sentence or word which he does not understnd.

Those pupils who have the correct attitude toward the function of reading will still vary widely in ability to acquire ideas from the printed page. Recent tests have removed from doubt the statement that there is a close relation between ability to read rapidly and ability to comprehend the material read. We have forsaken the old belief that the slow reader is the one who reads carefully and thoughtfully. We know now that, generally speaking, the slow reader is the one who also grasps the thought slowly and incompletely. A test which combines scores on rate and comprehension is therefore sufficient for classifying high school students.

(2) Reading rate and comprehension. An easily administered test which provides this composite rate-comprehension score is the Thorndike-McCall Reading Scale--provided the time period for the test is sufficiently restricted to measure reading rate. It contains material of sufficient range in difficulty to meet the demands of both superior and inferior readers in the secondary school. Recently the survey of a Kansas high school discovered a number of children with reading ability as low as the average for the fifth grade. The presence of such poor readers in our high schools is not uncommon. Reading difficulty affects their progress in subjects oftener than English. It appears the first duty of the English teacher to

teachers at Oread Training School so to adjust the reading assignments of students as to obtain for them a high degree of satisfaction and pleasure in their individual reading. The following tests are used in combination with a careful examination of student reports on summer reading, preferences, and home assistance.

(1) Oral reading. Ability to appreciate literature is a highly complex process. A recent analysis of appreciation lists six distinct phases, and admits frankly that these are merely the obvious elements in appreciating literature.[1] We are inclined to assume that the ninth grader has mastered what we term the mechanics of reading; that he has learned to grasp words as units, and also to comprehend as units phrases, sentences, and paragraphs. It is usually assumed that he knows that reading is more than the naming of words. Until these things have been accomplished a study of literature is doomed to failure. A simple way to discover whether the child has learned to expect meaning from his reading is to have him read aloud, while the teacher notes his reaction to difficult and new words.

Almost any group of high school freshmen will include some pupils who are not annoyed at a total lack of understanding of words, phrases, even sentences. Recently in the writer's class students were reading the trial scene from "The Merchant of Venice". A fourteen-year-old, reading Antonio's farewell to Bassanio, said: "Commit me to your horrible wife." The reader will perhaps recognize this as a perversion of the original speech: "Commend me to your honorable wife." When the class laughed the reader was puzzled, although he knew the meaning of both"horrible" and

freshman pupils regarding words found in class reading. A careful testing of the class, however, showed no pupil below ninth grade standard on vocabulary. It is frequently difficult for the teacher to recall the slow process of learning words. A diagnosis based on objective tests leads to more sympathetic teaching. Two tests suitable for high school use are the Inglis Tests of English Vocabulary (two forms, A and B) and the Holley Sentence Vocabulary Scale. Both are multiple choice tests, and are based on the use of words in sentences. They are therefore especially valuable as a basis for judging the pupil's ability to understand words in his reading.

Four items we may therefore discover as a basis for gauging the pupil's reading ability: (1) his attitude toward written material (Does he expect to understand what he reads, and is he annoyed if he fails to do so?); (2) his rate-comprehension score, in terms of reading age; (3) his comprehension unit (word, sentence, or paragraph); (4) his vocabulary development. Knowing these four things we should be able to assist the poor reader, and to provide adequate opportunity to the superior reader.

V. Literature: Remedial Measures

Remedial measures for the study of literature or the teaching of reading may be considered under two heads: (1) those designed to improve the reading ability of the child, increasing his rate and quality of comprehension and improving his vocabulary; and (2) those designed to help him adjust his reading limitations to the demands of his school life and to his future reading.

(1) Improvement of reading and development of vocabulary. A recent experiment at Oread Training School consisted of the organization of a literature class for all of the slow readers in the high school. These students were those whose reading age (based on both rate and comprehension) was at least two years below mental age. At the close of the year's work every member of the class was reading with at least the degree of proficiency to be expected as indicated by his mental ability. This success is of sufficient importance to warrant presentation here of the technique

see that remedial treatment is given. The range of achievement in reading is as great as the wide range in composition abilities. In the same class may often be found those who read with fourth or fifth grade understanding, and those who equal college students in both rate and comprehension. To ignore these differences is to avoid one's teaching responsibility.

(3) Comprehension unit: word, sentence, or paragraph. Individuals who make a low score on such a reading test as the Thorndike-McCall may be given the three reading sections of the Stanford Achievement Test. This test, while not suitable for the better high school readers, is most valuable in discovering the elements of difficulty for slow readers. There are three parts to the test, involving respectively the child's ability to grasp the meaning of words, sentences, and paragraphs. A knowledge of the pupil's comprehension unit, information essential to intelligent assistance, is thus obtained.

(4) Vocabulary development. Although investigators have discovered a close relation between general intelligence and vocabulary development, the agreement is not perfect. Environment, whether real or vicarious, may undoubtedly determine many vocabulary tendencies. To know the child's development in word knowledge is essential for the teaching of both reading and composition. A vocabulary markedly below that which the general ability would lead one to expect demands especial consideration. Student teachers at the training school were annoyed by what they felt to be the stupidity of freshman pupils regarding words found in class reading. A careful testing of the class, however, showed no pupil below ninth grade standard on vocabulary. It is frequently difficult for the teacher to recall the slow process of learning words. A diagnosis based on objective tests leads to more sympathetic teaching. Two tests suitable for high school use are the Inglis

and stories were chosen with a view to variety of setting and style.

(2) Adjustments to limitations in reading. In addition to the reading of short units, with emphasis on increase in speed, effort was made to see that the child learned to enjoy close reading. This was accomplished by careful analysis of the interesting plays and novels available for class work. Discussion of technical points was omitted. Reading lists for collaterals were provided containing books suitable to these slow readers, who were not permitted to attempt books beyond their ability. The students included in the experiment class just reported were by no means the only ones requiring careful adjustment.

An equal group of superior readers demanded even more attention. Extensive collateral reading lists were arranged to meet the needs of these students. Books sufficiently simple for the slowest, and others stimulating enough to tax the best readers in the school were provided. Those pupils whose reading difficulties are marked are offered collateral reading which will assist them in understanding history or other subjects for which a general reading background is essential. Students are given assistance in the selection of books and advised to read material suited to their tastes and abilities. No secret is made of the fact that what is approved for one is not for some other person in the same class. Pupils usually recognize these differences in interest and habits, whether requirements be uniform or individualized. The teacher should not pretend to be blind to an obvious situation.

Frequently it is found that pupils--especially boys--insist that they cannot read or do not like to read. Without some objective measure the teacher may be led to believe that such a pupil-diagnosis is correct. An illustration may make this statement more to the point. R was always behind with his outside reading, and met only minimum requirements on class work. He never read in advance, and occasionally failed to read with the class. He insisted that he did not like to read, and could not find any books he enjoyed. He had all the appearances of being a poor reader. His score on the Thorndike-McCall Reading Scale, however, indicated that he had average second year high school ability. He possessed a normal vocabulary

used in the experiment. Methods of procedure used were easily adapted to students in any class.

First, all outside readings were limited to simple material which the child could comprehend easily. This was done in order to assist him in experiencing the satisfaction of comparatively rapid reading. He was asked to time himself, noting his improvement from week to week. These records, while fairly accurate, were not made a burden. It was felt that error was preferable to any unpleasant association with the reading. Since the slow reader is often denied pleasure in his reading through the very slowness, materials were chosen which furnished a series of episodes rather than a long drawn-out plot. Such novels as those of Sabatini, while perhaps lacking in literary flavor, give satisfaction to these slow readers. "Tom Sawyer," with each chapter a unit in itself, is valuable. Two short books are usually preferred to one long one.

We have yet to determine the relation of rate to enjoyment in reading. Certainly, however, the teacher of literature must recognize that his own enjoyment of many beautiful passages and lively descriptions would be lessened were his rate of reading as slow as that of many high school pupils. We have also much to learn about the reasons for the popularity of the movies. Perhaps the element of time is more important and more legitimate than we have realized. For the sake of vocabulary development, books and stories were chosen with a view to variety of setting and style.

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dents in this course, although chosen from all but the freshman class are able (1) to read foreign literature in translation, (2) to read independently many classics ordinarily read slowly in class, and (3) generally to develop habits of reading suitable to their ability and tastes.

Such a class, while taking additional teaching time, relieves the regular classes to such an extent as to be a feasible addition to the curriculum of the ordinary school. Teachers know well that it is frequently the brilliant student who is not fully interested, who makes a problem of an otherwise easy class. The method suggested, of taking these brilliant students out of their regular courses and grouping them, relieves this situation. It is found that the superior sophomore is more likely to find himself at home in a special class, even though that class contain seniors or juniors, than he is in his own class where his ability is not taxed. Since such a class as the one here reported is based on achievement rather than on mental test scores, and since entrance is voluntary, unpleasant comparisons are avoided.

The comprehension of these superior readers is indicated by their book reports. At Oread all collateral readings are reported in personal conferences with the teacher. These reports seldom require more than five or ten minutes and are given at regular conference hours, or at odd times when teacher and pupil happen to have a few moments of leisure. Occasionally a group of pupils will talk for an hour with the teacher, in the conversation covering many reports. One fifteen-year old read "Dear Brutus". He was asked how he enjoyed the book. "It is very clever," he replied, "But I think circumstances influence us more than Barrie believes they do. I'd have changed the people in the last part of the play."

Another lad of fourteen asked: "Is there any story to "Round About to Canterbury?" "No," responded his fifteen-year old classmate. "You read that mainly for the descriptions and the style." "O, I see," replied the first. "Then I may dip in where I please." Another boy read "Vanity Fair". "I like it," he said, "but Thackeray is a bit cynical, isn't he?"

and normal mental ability. He was not overworked. He continued to check out books, try them, and bring them back half read. He was continually trying to secure permission to change from one book to another. His like may be found in many classes.

Since tests showed that he had mastered the mechanics of reading, however, his case was simplified. His teacher advised Doyle's "The Hound of the Baskervilles". To his amazement, R found himself reading a book at one sitting. Another detective book followed, and then an adventure tale. He is now reading at an average rate of more than one good book a week. Had his instructor not had definite knowledge as to the boy's ability, the story might have been quite different.

Not only do objective tests indicate those students who are in need of special assistance because of low achievement, but they discover a group whose ability is not often tested by the average school course. Each year at the Oread School a special class if offered to those rapid, superior readers who care to avail themselves of the opportunity. In spite of the fact (1) that this course offers keener competition for grades, (2) that members must read at least one book each week, and (3) that the class meets only three times per week, thus requiring additional initiative on the part of the students, there is always a demand for the course. Students in this course, although chosen from all but the freshman class are able (1) to read foreign literature in translation, (2) to read independently many classics ordinarily read slowly in class, and (3) generally to develop habits of reading suitable to their ability and tastes.

rectness, by S. A. Leonard	son, Wisconsin.
3. Wilson Language Error Test	World Book Company, Yonkers-on-Hudson New York.
4. Stanford Achievement Test, Language Usage	World Book Company, Yonkers-on-Hudson, New York.
5. Diagnostic Tests in Competition by Pressey and others. (a) Capitalization (b) Punctuation (c) Grammar (d) Sentence Test	Public School Publishing Company Bloomington, Illinois
6. Barrett-Ryan English Test	Bureau of Educational Measurements and Standards, Kansas State Teachers College, Emporia, Kansas
7. Sixteen Spelling Scales, Standardized in Sentences for Secondary Schools, by Thomas H.Briggs and Truman L. Kelley	Bureau of Publications, Teachers College, Columbia University, New York City.
8. Thorndike,McCall Reading Scale	Bureau of Publications, Teachers College Columbia University, New York City.
9. Stanford Achievement Test Reading: Paragraph Meaning Reading: Sentence Meaning Reading: Word Meaning	World Book Company, Yonkers-on-Hudson New York City
10. Inglis Test of English Vocabulary	Ginn and Company, Chicago
11. Sentence Vocabulary Scale by Charles E. Holley	Public School Publishing Co. Bloomington Illinois.

When asked to explain he replied: "Well, anyone who would say life is Vanity Fair, would have to be a little cynical, wouldn't he? And there's the way he did Becky's life, you know." There is little value for such pupils in many of the assignments which the slow reader finds interesting and necessary. Teaching they doubtless need, but teaching which will tax, not weary them.

As with the study of composition, such a program as that just suggested savors of individual teaching. If our aim is to develop reading habits it is hard to see how anything short of individualized instruction is possible. Nothing else taught in school can be more personal than the pupil's use of his native tongue. It is his tool for making himself known to his fellows, and his key not only to the facts of the physical world but to the thoughts and feelings of the other individuals in the world. It is bound to be a personal matter when anyone attempts to aid or direct him in the use of that tool, a matter too serious to permit any but the most careful approach.

List of St dardized Tests in English Mentioned in This Paper

1. University of Wisconsin Sentence-Recognition Test, by S. A. Leonard	University of Wisconsin Press, Madison, Wisconsin.
2. Wisconsin Test of Grammatical Correctness, by S. A. Leonard	University of Wisconsin Press, Madison, Wisconsin.
3. Wilson Language Error Test	World Book Company, Yonkers-on-Hudson New York.